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Adapting to climate change in developing countries: institutional and policy responses for urbanizing societies

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Abstract

Climate change and urbanization combine to result in high risk for cities worldwide, but particularly in developing countries. The UN-HABITAT estimates that 60% of the world's population will reside in urban areas by 2030. Dealing with the development 'backlog' in cities will thus be imperative for addressing the additional challenges posed by climate change. Adaptation to climate change poses an institutional, planning and public policy challenge for all cities around the world. Many measures to address urban problems will also be able to reduce vulnerability to climate change, but there are limits to how effective measures to adapt to climate change can be in cities where existing institutions are already inadequate. Coupled with the existing battle to grapple with urbanization, this 'double feature' offers a worryingly large task list for urban governments in developing countries. Factors that are obstacles to development now must be first and foremost addressed in order to reduce vulnerability to climate change. While infrastructure and zoning are important components of urban adaptation, policies and institutions based on good governance need to lie at the core of all efforts. Such a process must create an equitable enabling environment that recognises the tradeoffs: adaptation for some may imply increased vulnerability for others. Examples of successful implementation of measures to reduce exposure and sensitivity to climate change and disaster risk are few, but those available offer useful insights into planning and policy options. Where adaptation will require additional funds beyond what should already be allocated for sustainable urban development, it is not clear what the source will be. Poor institutions, infrastructure and regulations in developing country cities are obstacles to sustainable development but should be seen as opportunities for adaptation.

Introduction: Welcome to the Double Feature

> *'The adaptability of our species to life in an increasingly urban world should indeed be a topic of research.'*
>
> *Moran (2006: 325)*

Climate change and urbanization may be two of the most confounding problems currently facing planners worldwide. Not only scientists and decision makers are confronted with the challenge: globally, city dwellers are endeavouring to come to terms with both of these at once, consciously and unconsciously. Inadequate policies and plans to deal with existing development challenges suggest even greater difficulties in the future to deal not only with each issue on its own, but also to address the compounding effect of the two processes together. Ironically, climate change is likely to be a significant driver of migration towards cities over the coming decades, exacerbating existing problems posed by urbanization and further raising urban vulnerability to climate change.

Every day, the world becomes more urban. Cities in developing countries already now largely fail to implement policies and strategies to prevent environmental and service challenges ahead, and are outpaced by actual development taking place with fervour around them. Besides the obvious challenges posed by poor urban planning, such as air pollution, chaotic traffic or deficient access to and provision of services – which is part of the 'backlog' of development for many citizens (Satterthwaite, 2008: 12) – some adverse aspects of urbanization may only become obvious in a crisis situation. Settlements often materialise in

high-risk areas, such as river banks or unstable hill slopes, without any planning strategy or consideration of future consequences. While daily struggle enables life to go on in such locations, the impacts of a flood or an earthquake quickly reveal the inadequacy of such solutions. Realistic policies to identify and influence formal and informal development in these areas is essential, as is the allocation of alternative areas for development in order to anticipate and shape the vision for the city and provide sustainable expansion land for affordable housing. Preventing informal settlements in areas that should not be developed requires governance structures to be addressed at their source. This requires a solid institutional basis, with city visions and master plans, supported by an institutional fabric that often does not exist in many developing countries. The strain on cities in developing countries is already enormous; adding climate change to the picture requires a paradigm shift in urban planning.

Dealing with the realities of rapid urbanization requires a sincere acknowledgement of the other factors at play. Climate change is the most important of these, but also brings its share of unanswered questions, particularly in terms of how to reduce its impacts. In step with climate change becoming recognised as the greatest threat to human and ecological security of our time (O'Brien *et al.*, 2008), responses to its experienced and anticipated impacts have become a global priority. A proliferation of scholarship on adaptation to climate change is evident in the last decade (Schipper and Burton, 2009). Nevertheless, translation from theory to practice, and in particular to proactive engagement, has been held back not only by a lack of funding for it, but also by lack of a clear and shared vision of how to 'do' adaptation. Until recently, adaptation efforts have been focused on rural areas, with little attention paid to cities (Sanchez-Rodriguez *et al.*, 2008). With the recognition that cities are drawing the largest settlements, it has also become clear that adaptation to climate change in cities needs to be a major area of research and action. Satterthwaith (2008) believes that recent research on the scale of urban vulnerability to climate change means that the need for action by city/municipal governments on adaptation is more urgent than previous accepted wisdom included in the IPCC's Fourth Assessment Report (2007) indicated. In most developing countries adaptation poses an institutional, planning and public policy challenge. Coupled with the existing battle to grapple with urbanization, this 'double feature' offers a worryingly large task list for urban governments.

The challenges posed to adaptation intersect with many of the historical challenges to development. Soussan and Burton (2002: 3) propose that thinking about and planning for adaptation could be a chance to revisit 'some long-standing problems of environment and development in an innovative way'. This suggests that merging the agendas of climate change adaptation and urbanization require creative approaches but also offer new possibilities. Similarly, tackling adaptation to climate change may also introduce new opportunities to examine adaptability of humans in cities, given that capacity to cope with existing challenges is inadequate (Moran, 2006).

As with all development issues, more questions than answers exist. When it comes to climate change, time is of essence (Parry *et al.*, 2008a). Despite that the international political community has accepted that more stringent legislation on reducing greenhouse gas emissions will be necessary, they are largely in denial about the sacrifices required in order to

meet the targets (Parry *et al.*, 2008b). As the pressure on cities grows due to growing populations worldwide, the stress is compounded exponentially by climate change.

While not providing exhaustive answers to this challenge, this paper highlights the key issues related to adaptation to climate change in urbanizing societies in developing countries. It examines not only the complexity of dealing with urbanization and climate change simultaneously, but also the role that urbanization plays in influencing the impacts of climate change, and the way in which climate change will affect future trends in urbanization. The paper emphasises how to identify response options that reflect these dynamics adequately. The assessment of findings suggests that there are unique complexities in urban areas, requiring different approaches to adaptation than in rural settlements, and reinforces other recent calls for further research on this topic, which has been mostly left out of the climate change debate until now. Key entry points for responding to climate change in urbanizing societies are examined in the final section, focused on enabling institutional arrangements and policy options.

Adaptation, Development and Risk: The Starting Point

As climate change science and policy have become more certain, responding to climate change has taken up a prominent position on policy agendas worldwide. Climate change has been described as the defining issue of the 21st century in terms of environment, development and human security (O'Brien *et al.*, 2008). In 2007, the Intergovernmental Panel on Climate Change (IPCC) acknowledged that there will be both unavoidable impacts and irreversible changes as a result of climate change that will go beyond current coping capacity, and to which society and ecosystems will need to respond (IPCC, 2007). Adaptation is one of the two ways to respond to the changing climate – along with mitigation of greenhouse gas emissions – and is even more essential now than ever, as the changes in climate become more frequently observed. Simultaneously, interest in adaptation to climate change is growing exponentially in terms of both research and policy. However, there are numerous gaps in our knowledge of how to implement adaptation, and the issue remains infused with conceptual challenges.

In the last six years, adaptation has risen to the top of the global climate policy agenda, but the climb has been slow and arduous. In the early 1990s, a handful of scientists and policymakers began insisting more ardently that adaptation had been the ignored counterpart to greenhouse gas mitigation, cautioning that not taking adaptation seriously could have serious consequences for future development (see eg. Schipper 2006; Pielke Jr, *et al.*, 2007; Ford, 2008). During this period, tension between those favouring mitigation over adaptation contributed to creating a divide among actors in climate change policy, globally and locally (eg. Tarlock, 1992; Burton 1994; Pielke Jr., 1998). The historical development of adaptation from concept to policy objective indicates why adaptation's popularity rose only slowly after the entry into force of the UN Framework Convention on Climate Change (UNFCCC) in 1994 (Schipper, 2006). As a result of events since that time, both attitudes, needs and scientific evidence have changed. Today there are strong grounds for having adaptation as a policy goal, but this is not without a degree of debate. While clear questions related to adaptation are emerging, including what it is, how it can be stimulated, and what its limits are, the answers mostly remain unclear.

In examining the emerging adaptation discourse, it is possible to identify three major components of adaptation: theory, policy, and practice (Schipper, 2007). Although they are inherently linked, they revolve around somewhat discrete sets of actors. Adaptation theory is driven by scientists and scholars and hence remains focused on building a field of study, but with a very strong applied and socially relevant direction including field work and case studies (eg. Leary *et al.*, 2008a, 2008b). Adaptation policy is based on operationalising adaptation under the UNFCCC, thus focused on funding, technology transfer and capacity building (eg. Harmeling and Bals, 2008; Persson and Klein, forthcoming). In response to adaptation policy, and even more in response to the *lack* of adaptation policy, adaptation practice, in particular projects, have begun emerging (eg. McGray *et al.*, 2007). These are initiated primarily by development organisations – donor agencies, NGOs and grassroots organisations.

One of the greatest limitations to adaptation in the past has been gathering momentum to move away from seeing it as a 'global' objective towards understanding it as a 'local' issue. Because the UNFCCC was the main driver of adaptation to climate change until recently, adaptation was presented as a national issue. But adaptation policy is mostly a matter for national and local-level governments within an internationally supportive and enabling framework. This presented difficulties for local governments, including cities, who had little institutional guidance or support for implementing adaptation measures. This has now shifted in the right direction, with community-based adaptation being one of the most successful approaches to adaptation. Despite this, most of this attention has focused on rural areas; adaptation in urban environments has received scant attention (Moran, 2006; Sanchez-Rodriguez *et al.*, 2008). Focus on climate change and cities has primarily addressed mitigation-related issues, such as reducing greenhouse gas emissions associated with heating, cooling, transportation and other urban activities (UN-HABITAT, 2008), and left adaptation surrounded by question marks.

Definition

Adaptation[1], as defined specifically in the climate change context, is the process of adjusting to a changing climate, through explicit and planned interventions, or spontaneously as a consequence of inherent flexibility. Because climate change will affect every aspect of society, environment and economy, adaptation includes activities that are both directly and indirectly related to the impacts of climate change. Although adaptation to change has a long history both in ecosystems and human societies, it is only in the last two decades that scientists and a growing number of policymakers have begun to grapple with how humanity can actually adapt in a planned and strategic way as the climate changes. In part, this is because although adaptation to climate is as old as humankind, adaptation to rapid anthropogenic climate change is a new challenge.

There is some value to understanding the different 'typologies' of adaptation as they were originally discussed by Smit (1993). Table 1 summarises the most useful of these. While

[1] Environmental anthropologists, political ecologists and other scientists also study 'human adaptability' (Moran, 2006). Much of the theory found in these fields can be directly applied to climate change adaptation, and is more theoretically grounded, since they stem directly from existing fields of enquiry. Climate change adaptation science is a relatively new field, and has much to learn from existing social science approaches to adaptation.

they may seem utterly academic, these typologies are in fact practical for designing policy. Understanding the various characteristics of adaptation is helpful in order to identify adaptation on the ground, or to be able to assess whether on-going measures are part of the adaptation process. It is primarily in the level of consciousness, timing, planning and spatial scope that adaptation can be distinguished. Thus, the typologies are practical for understanding when the adaptation process begins, where it can be focused, who and what adapts and who and what drives the adaptation process. From a policy and project perspective, answers to these questions are fundamental. In efforts to combine adaptation measures with other policies, understanding the dynamics of the typologies can also be vital.

Table 1. Different adaptation typologies

Typology	Main Descriptive Term	Additional/Alternative Terms
Purposefulness	Planned	Public, Purposeful, Intentional, Policy, Active or Strategic
	Autonomous	Private, Spontaneous, Passive, Natural, Incidental or Automatic
Timing	Reactive	Responsive or ex post
	Anticipatory	Proactive or ex ante
Duration	Strategic	Long term or Cumulative
	Tactical	Short term, Instantaneous, Contingency or Routine
Location	Localised	Cities, Urban Settlements
	Wide-spread	National, Regional, International

Source: Based on Smit and Pilifosova (2001)

Adaptation and Development

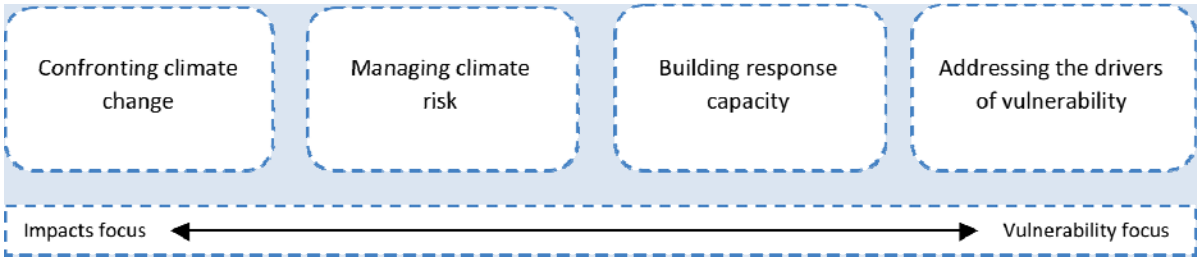
Poverty, access to resources, health and education and all of the other development objectives that fall under the Millennium Development Goals influence vulnerability to climate change (Schipper *et al.*, 2008; AfDB *et al.*, 2003). Adaptation measures are concerned with human development, because factors that constrain and facilitate adaptation are often the same as factors that constrain or enable human development. While people can (barely) manage to survive under difficult conditions with current weather patterns, when climate change is imposed on an already precarious livelihood situation, it may push it over the threshold into an unviable existence. Living on the fringes of urban life is case-in-point. While slum-dwellers settled along a river bank can manage to cope with an occasional flood in the sense that they might lose belongings but life can go on, more frequent flooding of greater magnitude will likely bring disruption that will push the settlers to seek shelter elsewhere. Given that they are living in an undesirable location already, chances are that they have few

better options. This may push them further down the poverty ladder, and likely also increase their exposure to climate change.

The main points of conceptual divergence with respect to adaptation and development centre around the question 'Adaptation to what?'. Although this has been tackled by numerous scholars (Pittock and Jones, 2000), there are two somewhat distinct approaches apparent in literature and policy: one focused on creating response mechanisms to the impacts of climate change; and another focused on adjusting livelihoods to reduce exposure and sensitivity (*ie* vulnerability) to climate change (Schipper, 2007). These are not the same. The former places the climate change impacts at the centre, and attempts to identify ways in which distinct impacts can be reduced. The types of activities in this approach include building coastal defences in response to sea-level rise or changing tides, or developing irrigation systems in response to less rainfall. The latter approach, on the other hand, is far more holistic in that it targets the underlying factors that are causing the impacts to be harmful. Such a 'vulnerability reduction approach' requires dealing with issues such as unequal wealth distribution, gender discrimination, and rapid urbanization, which are already some of the most challenging development conundrums. This is particularly relevant in the context of urbanization, where numerous other processes compete with each other to challenge sustainable urban growth.

The second approach focusing on underlying causes of vulnerability is not only beyond the mandate of most climate change policy or projects, but is also massive in scope. The first approach, where adaptation is an additional process that can be fitted on top of other development activity, suits existing policy and funding structures better. It also directly addresses climate change. On the other hand, the first approach is in the large majority of cases far too superficial to have a long-term effect. It may also be associated with creating vulnerability in the long term ('maladaptation'), by ignoring the underlying factors that translate climate change into an adverse impact (Schipper, 2007). McGray and colleagues expanded on this idea in their 2007 report, which characterises this divergence as extremes on a 'continuum', illustrated by Figure 1. This means that efforts to respond to climate change must good hand-in-hand with more basic development processes, such as reducing hunger, enhancing access to resources, and improving health, although this is already a very tall order facing numerous challenges (Agrawala and van Aalst, 2008).

Figure 1. The continuum of approaches to adaptation from focusing on impacts to vulnerability



Source: Based on McGray *et al. (*2007)

Societies are dynamic and resilient to a point; they have faced and overcome obstacles of all sorts throughout time, but they have also suffered to the point of collapse (Adger and Brooks, 2003). The past perspectives on natural hazards discounted the importance of human agency (Pelling, 2003), suggesting instead that hazard impacts are beyond human influence. The updated view reflects that risk is composed of both hazards and vulnerability to them (Blaikie, *et al.*, 1994). This focuses on the underlying causes of society's vulnerability, which include political power, gender, age, caste, religious beliefs, and are often embedded in cultural norms. In recognition of the human influence on hazard, as well, Hilhorst (2004) has suggested the importance of considering the 'mutuality of hazard and vulnerability', which reflects that human behaviour influences vulnerability, but also affects hazards. Climate change is the perfect example, as it is anthropogenically caused and will affect people who are already vulnerability to climate hazards. But climate change will also affect people who have not previously been exposed to hazards since it will change weather patterns.

The conceptual challenges related to adaptation pivot around the diverging entry points for implementing it, and in particular the its relationship vis-à-vis development. Although many have stressed and demonstrated the close link between adaptation and development and the urgency of mainstreaming climate change into development (eg. O'Brien and Leichenko, 2000; AfDB, 2003; Adger *et al.*, 2003; Huq and Reid, 2004; Persson and Klein, forthcoming), the reality is that adaptation is still seen as an 'extra' layer within policy and practice (O'Brien *et al.*, 2008). Unfortunately, this suggests that adaptation will not as effective as it could be if instead the starting point were a rethinking of the overall development paradigm (Schipper, 2007). In the worst case, as Burton and van Aalst caution (2004), this will have unintended and adverse consequences on the development process.

Disaster Risk Reduction

Disaster risk reduction has been recognised as an important and necessary component of responding to climate change, because climate change is expected to imply more extreme weather, with changes in frequency, magnitude, and location (IPCC, 2007). While disaster risk reduction claims its own field of practice and study, the linkages between disaster risk reduction and adaptation have recently emerged as an important overlapping area (Schipper, 2008; Mitchell and van Aalst, 2008). The efforts to strengthen the overlaps have stemmed from a variety of actors, including NGOs like Tearfund, Oxfam and CARE, to research institutions such as Institute of Development Studies (IDS) and Stockholm Environment Institute (SEI), as well as multilateral and intergovernmental agencies such as ProVention Consortium, UN International Strategy for Disaster Reduction (ISDR) and the Asian Disaster Preparedness Centre (ADPC).

Urban disaster risk reduction is a particular sub-set of practice and study within disaster management. Practitioners' emphasis in this context is primarily on infrastructure, land-use planning and regulatory measures, including awareness raising. Institutions to address disasters are typically weak, although this is often not their own fault. They traditionally focus on relief – i.e. getting everyone out of danger, searching for missing persons, and providing short-term shelter and food. This may encompass preparedness, which includes relief plans and some awareness-raising activities, but the process rarely includes risk reduction, which emphasises the reduction of sensitivity and exposure to hazards. Disaster risk reduction practitioners and scholars suggest that adaptation to climate change should be

coupled with disaster risk reduction, not only because the two deal mostly with the same types of hazards[2], but primarily because of the need to address the underlying issues driving vulnerability to such climatic stress (Schipper, 2008). Indeed, adaptation to climate change and disaster risk reduction demand the same emphasis on vulnerability reduction and sustainable long-term strategies to reduce adverse impacts. Both adaptation and disaster risk reduction implicitly recognise that risk is part of everyday life, and thus part of development.

Box 1. Adaptation and disaster risk reduction

At the heart of the tensions between disaster risk reduction and adaptation institutions lies a set of theoretical and practical issues. Although Satterthwaite (2008) is surprised that disaster risk reduction has not had a more central role in adaptation, there are some important reasons why this has not been the case. While adaptation and disaster risk reduction both focus on society-risk dynamics, their channels of implementation typically involve different actors, with different time horizons, policy processes and spheres of influence (Schipper, 2008). Despite their weaknesses, disaster risk reduction channels may be appropriate starting points for adaptation to climate change. One of the strengths of packaging climate change as another form of urban risk is that in most cities, some form of disaster management infrastructure is already present. Unfortunately, not all disaster management recognises that disasters are not caused 'naturally', but are the consequence of the intersection of hazards with citizen's vulnerability to these hazards. Instead, most post-disaster processes of relief and recovery aim to return to 'normalcy', rather than focus on the conditions that cause risk and vulnerability, some of which are directly or indirectly related to this 'normal' state, including activities, settlement patterns and perceptions.

The World Bank (2008) suggests that 'hot spot' cities – who are at risk from disasters and climate change – are based on the following criteria:

- Moderate to high exposure to natural hazards.
- Medium or high observed vulnerability to past hazards.
- Moderate to high sectoral vulnerability to climate change.
- Poor or non-existent urban development plan or growth plan.
- Poor compliance with urban development plan or growth plan.
- Poor quality of building stock.
- High population density.
- Medium to large population or high decadal growth rate or high population density in case of low population.
- Medium or high slum density or large proportion of informal population.
- No comprehensive disaster response system.
- Economic and/or political significance in regional or national context.

[2] Earthquakes are the notable exception, although earthquake damage may be worsened as a consequence of saturated land and unstable infrastructure as a result of storms, flooding or other damaging weather events.

Many cities fall into at least one, but typically more, of these categories. The difficulty is that it is often not easy to identify to what extent these factors are relevant for a city, nor to assess their status. Furthermore, a low rank in one of these criteria does not necessarily imply a low rank in another criteria. For example, many cities in Asia have high exposure to natural hazards. But exposure of population is not the same as risk to infrastructure. The OECD study of the status of coastal cities in 2070 (Nicholls *et al.*, 2007) indicates that while the populations of Kolkata and Mumbai (both in India) will be the most exposed to coastal flooding among cities worldwide, Miami (USA) and Guangzhou (China) will have the most exposed assets among global coastal cities. The study suggests that a better understanding of the drivers of exposure will enable more effective adaptation plans (Nicholls *et al.*, 2007). Importantly, the study reflects that not only climate change will be the driver of exposure to coastal flooding in these cities, but also 'socio-economic change'.

Looking at the list of criteria proposed by the World Bank publication (2008), it is clear that many of the drivers of the state of these criteria are not directly related to natural hazards and climate patterns, if at all. Population density, infrastructure quality, urban development plans and disaster response systems are influenced, and indeed determined by social, economic, political and environmental factors. The existence of comprehensive development plans, appropriate regulations and a solid disaster response system is a question of good governance. Importantly, the existence of any plans, regulations and responses systems, however good and bad, cannot be taken for granted. Whether or not adequate, implementation of these measures and, ultimately, their success, is dependent on reliable institutions. Plans and institutions to support them thus lie at the heart of successfully reducing risks of natural hazards, including climate change, in cities. This is therefore where efforts to adapt to climate change in cities should be focused.

Box 2. Disaster Relief and Recovery Gone Wrong: Central America after Hurricane Mitch

The study of relief and recovery processes following disasters can provide valuable lessons, not only about what works and what doesn't work, but also about how quickly memories fade.

Ben Wisner describes the irony of disaster relief and recovering in his 2001 paper looking at two major disasters in El Salvador: the 1998 hurricane Mitch and two considerable consecutive earthquakes in January and February 2001 (Wisner, 2001). A study of the recovery process following Mitch noted that the Salvadoran rhetoric about learning lessons after the hurricane had not been translated into action. Houses that had been built to provide 'temporary' shelter for those who had lost homes in 1998 were still serving as homes in 2001. These shelters, not fit to withstand earthquakes of the magnitude that occurred in 2001, collapsed. Although new institutions had emerged to reduce disaster risk, by the time the earthquakes hit in 2001, Wisner acknowledges that the time between 1998 and 2001 was too short for the new institutions to have any significant impact.

A more recent study of the recovery process after Mitch in Nicaragua, which along with Honduras was the most badly affected during the 1998 disaster, indicates that few lessons

have been applied there too, ten years after the hurricane. The study (Christoplos *et al.*, forthcoming) has found that the rhetoric of disaster risk reduction has been infiltrated by rhetoric of climate change, but linked to carbon sequestration rather than adaptation to climate change. There was only limited evidence of pro-active engagement, policy making and institutional restructuring in Nicaragua. As the seasonal rains flooded large parts of the Central American region, it marked the 10-year anniversary with relative indifference. Indeed, the local newspaper reflected the same sentiment around the time of the 10-year anniversary.

The cartoon (Molina, 2008), shows a family sitting on its rooftop in 1998, and again in 2008. The family says "We should prepare ourselves so that this doesn't happen to us again!".

Complexities of Urban Risk

'Many poor urban dwellers live on the worst quality land on the edges of ravines, on flood-prone embankments, on slopes liable to mudslide or collapse, in densely packed areas where fires easily start, on roundabouts at busy intersections.'

Sanderson (2000: 92-93)

Cities matter, and now more than ever. Satterthwaite points out that 'even predominantly rural nations generally have more than half their GDP derived from industry and service enterprises, most of which are in urban areas' (2008: 3). Cities also serve as hubs to stimulate regional and international growth and are 'key nodes of the globalisation process' (Sanchez-Rodriguez *et al.*, 2008: 4). Cities represent hope and possibility for residents and migrants. But they are also a gathering place for marginalised groups and the root of unbounded environmental degradation, which compounded with natural hazards results in cities being home to significant risk. Estimates tell us that 60% of the world's population will reside in

urban areas by 2030 (UN-HABITAT, 2008). Dealing with the development 'backlog' in cities will thus be imperative for addressing the additional challenges posed by climate change.

Trends in population growth can indicate what future pressure will be for cities, particularly many large cities in Asia. The OECD study indicated that among the 20 most vulnerable cities to coastal flooding, nearly all of these are in Asia (Nicholls *et al.*, 2007). But other regions are equally of concern. Satterthwaite (2008) points out that recent UN statistics (2006) indicate that contrary to the traditional rural landscape associated with Africa, two-fifths of the continent's inhabitants are urban.

There is a certain degree of confusion in the field of climate change as to what 'risk', 'hazard' and 'vulnerability' actually mean, and the relationships between these[3]. This confusion can also be noted with respect to what represents a risk in a city. Urban environmental risk often refers only to issues such as air and water pollution and inadequate waste management. Other risks in cities include coastal erosion in coastal cities, flooding from rivers, landslides, earthquakes, and diseases such as dengue, cholera and malaria and sanitation-related health risks that have a high impact in developing countries, where sanitation is often far below standard – or nonexistent – for those living 'outside' formal services (UN-HABITAT, 2008). Anthropogenically caused impacts include the urban heat island effect, which is caused by the high absorption of solar radiation in urban environments. Because urban environments are warmer, people tend to use cooling appliances such as air conditioners more intensely. Ironically, for every couple of air conditioners turned on, further air conditioners might be turned on in response to the heat generated by the cooling process.

Box 3. The impacts of climate change on water.

Access to water resources are essential to life; settlements can only exist where freshwater is available. Cities such as Mexico City have already seen the adverse impacts of a large population on limited aquifers. Groundwater is not always renewable, and in the case of Mexico, excessive extraction has actually resulted in land subsidence. Pollution of groundwater is also a risk. In Hanoi, research has shown that groundwater in the southern part of the city is contaminated by arsenic (Tran Thi Viet Nga, 2008).

The Intergovernmental Panel on Climate Change highlighted that water will be particularly affected by climate change (IPCC, 2008). The *Comprehensive Assessment in Water Management in Agriculture* (Molden, 2007) underscores that improved water management can have direct impacts on poverty reduction, because it is primarily poor water management and lack of water entitlements rather than physical water scarcity that cause water-related tensions and poverty (Castillo *et al.*, 2007). An even greater threat to the existing precarious water management systems is the increased variability in water availability that is a consequence of growing populations as well as a changing climate, requiring increased resilience in water management systems. But water management is composed of many elements, including infrastructure and institutions, which do not take large-scale, relatively rapid change and climate-related risks into account in their development and planning

[3] See Annex I for a list of key definitions.

(Biemans *et al.*, 2006), and which may not be sufficiently flexible. However, by applying a management framework that offers enough resilience to reduce the adverse effects of natural hazards, as well as long-term changes such as from climate change, population growth and environmental degradation, we can tackle poverty. This requires strengthening the resilience of water management systems, so that they can absorb shocks, incorporate ecological, demographic and institutional changes while also reducing poverty, best done in a concerted and integrated manner involving all relevant stakeholders.

Source: Schipper (2007b)

There are many ways in which climate change will affect urban areas (Sanchez-Rodriguez *et al.*, 2008). Climate change will both add additional risks, but also exacerbate existing ones. Most obviously, sea-level rise is a serious threat to coastal cities (Nicholls *et al.*, 2007). Also an increase in temperature will matter, especially during summers and hot seasons. In terms of direct impacts of climate change, probably most difficult will be understanding how increased climate variability will play out in cities. What will more frequent or greater magnitude storms mean for existing infrastructure, and what sort of new and additional risks will they pose on urban dwellers? How will the built environment cope with more intense rainfall? Poor drainage in cities in developing countries is already a serious issue (Satterthwaite, 2008). In Bangkok, risks of rodent-carried diseases is heightened in the rainy season, when large parts of the city are covered in rainwater that has nowhere to go. In some parts of the city, elevated walkways have been constructed, but these are often a way to increase pedestrian mobility in highly trafficated areas, rather than isolate people from stagnant surface water.

The other aspect of climate change is the secondary impacts that will occur, even when the primary impacts are experienced elsewhere. The most obvious example is in-migration resulting from failed crops in rural areas or disease linked to climate change. How will this additional pressure on services and water resources, infrastructure and urban ecosystems play out and be coped with among citizens and governance structures? And what will be the consequences on health and the environment? Will this pose new problems that in turn might exacerbate vulnerability of urban settlers to direct climate change impacts? Uncertainty abounds about how much autonomous and planned adaptation can enhance human resilience to climate change now and in the future, for rural, urban and peri-urban areas inclusive.

Box 4. Overlapping opportunities

In the concept of ‘maladaptation’ lies the notion that actions to address one problem might be ignoring or, at worst, causing another. There are a number of broader ways that this concept can be applied to climate change, besides adaptation.

Because many of the current environment-development problems require solutions that encourage behavioural change, policy has attempted to include everyone as ‘stakeholders’ – civil society, government, the private sector and any other relevant groups. This has led to a strategy of attempting to provide multiple incentives for environmentally-sound behaviour. While this may work in some instances, in others it may also lead to the creation of false causal links. One example is the transformation of ‘climate change’ into a marketing tool.

While 'green' products such as bags, clothing, cosmetics and food attempt to raise awareness of the need to take environmental protection seriously, they do not address one of the major drivers of humanity's adverse influence on our environment, namely consumerism, and in fact continue to encourage it.

Another approach to climate change has been to try to identify a single solution to address different problems simultaneously. This includes endeavours to identify strategies that both reduce greenhouse gas emissions while supporting adaptation, most famously in land-use change, forestry and agriculture activities (Klein et al, 2007). It may be fair to question whether benefits of such integrated solutions outweigh the efforts needed to actually craft them. In the case of cities, however, finding these overlapping opportunities might be a necessary solution.

Building 'sustainable cities' requires planning for the future, therefore considering demographic change, and related infrastructure, service and communication needs. These will also be key components of any adaptation strategy. Thus, it is clear that planning needs to take into account not only 'greening' of cities for health and aesthetic reasons, but also expected physical changes as a result of climate change and behavioural changes in response to those physical changes.

Various scholars have unpacked the issue of urban environmental risk (eg. David Satterthwaite and Mark Pelling), and others have examined dynamics between urbanization, vulnerability and poverty (eg. Caroline Moser). The issue of cities and climate change has emerged over the last two years as a timely topic, linking the larger climate change research and policy agenda with that of urban development, in recognition of that the majority of people now live in cities (UN, 2006). The World Bank, Rockefeller Foundation, Institute of Development Studies, International Institute of Environment and Development and the Organisation for Economic Co-operation and Development, among others, have over the past year or so initiated studies on cities' impacts on climate change as well as impacts of climate change on cities, including methodology to assess and understand cities' vulnerability to climate change. But few have successfully examined the question of urban adaptation to climate change in developing countries.

To date, there has been a substantial number of qualitative and quantitative studies of rural vulnerability and adaptation to climate change[4], some of which are part of projects. This is because land and water resources are seen as the most immediately affected by climate change, and these are the mainstay of the majority of rural livelihoods in developing countries, and consequently of the majority of the poor. While rural settlements have characteristics that set them apart from urban areas, it is important to recognise that urban areas are also unique. Findings and recommendations from rural studies and methodologies applied cannot necessarily be translated to looking at adaptation in urban areas. Ironically,

[4] See UN Development Programme's Adaptation Learning Mechanism website for examples http://www.adaptationlearning.net/resources/studies.php and the UN Environment Programme/Third World Academy of Science/Global Change SysTem for Analysis, Research and Training's project Assessing Impacts and Adaptations to Climate Change in Multiple Sectors and Regions (http://www.aiaccproject.org). See also Annex A of McGray *et al.* (2007).

cities have often been the destination for rural people whose livelihoods have failed them. The perspective that cities were a 'refuge from drought and famine' (Sen, cited in Pelling, 2006) may no longer be applicable. Cities, particularly is coastal areas, are exposed to natural hazards at an increasing pace. But they are becoming centres of risk not because of the hazards only: as solutions to addressing poverty continue to confound us, and urban populations are growing, vulnerability to these hazards are increasing at an exponential rate.

Box 5. Air Pollution and Climate Change: Reverse Correlation?

Recent science indicates new findings on the relationship between air pollution and climate change. Studies suggest that air pollution has been 'masking' the actual warming experienced, because air pollution aerosols are essentially serving to 'cool' oceans. In the study, Ramanathan and colleagues note the uncertain relationship between these two phenomena (Ramanathan *et al.*, 2005).

Ironically, urban air pollution has been one of the battles that is slowly, but surely, being won. Air pollution has been a major health hazard in cities since the beginning of industrialisation. But decreased urban air pollution might imply increased felt impacts of climate change in cities. On the other hand, many of the factors that contribute greenhouse gas emissions may also be responsible for air pollutants. Cars are the most striking example. Not only do they emit carbon dioxide, but they also contribute ozone.

In terms of prioritising activities, addressing air pollution stands out above climate change in that it can be more visibly demonstrated. For local decision makers, the priority is measures that provide more tangible results to local constituents. Nevertheless, the urban air quality agenda challenges significantly overlap with the climate change mitigation agenda. Mexico City and Santiago offer good examples where local air quality priorities are aligned with those for climate change. This results in high developmental value for less investment.

Urbanization poses challenges on its own, even without taking environmental or climatic aspects into account, let alone extreme events and disasters. Cities grow in various ways, including population and wealth increase and the physical expansion of a city. This influences everything from traffic patterns and infrastructure development to property value and crime rates. Urbanization is also a driver of environmental change, starting with landscape transformation. However, not all environmental degradation is driven by populations in search of food, land and opportunity. Often these processes are driven by government policies, such as in the Amazon where forest has been converted to agricultural land (Moran, 2006). Conflicting political agendas within government are the backbone of poorly functioning institutions, giving birth to self-serving policies that give to those with power and take from those without it. In such an atmosphere, the risk is high that climate change will be seen as another burden or obstacle, or will be characterised as a political pawn. Therefore, key aspects of urban development must be addressed regardless of climate change; but they should take climate change into account.

Sustainable urbanization must refer not only to a development path that takes ecosystems and future generations into account, but also one that considers other processes that affect cities and patterns of urbanization. As McGranahan and colleagues (1996) note, however, sustainability is not necessarily an ideal objective for all aspects of urban development. There are some 'sustainable' services in 'unsustainable' cities, which function well within the given limitations and conditions. The plethora of issues associated with urbanization cannot necessarily been seen in a linear way; the interconnectedness and mutuality of poverty (implying wealth, employment, health and education), environmental health and degradation, conflict, insecurity and safety issues, vulnerability to natural hazards, economic growth and fragility, and infrastructure development and planning are all part and parcel of what makes a city vibrate. In each case, the state of being of one of these aspects is related to the state of being of the others. While environmental degradation may not directly drive poverty, it may certainly serve as an obstacle for moving out of poverty.

Many have repeated that 'disasters turn back the development clock' (Sanderson, 2000: 95; see also DfID, 2005; UNDP, 2004). Pelling suggests that 'disaster risk is possibly the greatest threat to urban sustainability we face today' (2006: 6). This presents a third perspective on the relationship between climate change and urbanization. Not only is uncontrolled urbanization a source of vulnerability to climate change, and not only will climate change add new challenges and complexities urbanization, but also disaster risk and other climate change impacts will play a major role in impeding urbanization must be recognised. A more careful look at the drivers of urban vulnerability is required to fully reflect this element in the puzzle.

Urban Vulnerability

Sanderson believes that 'it is no surprise that increasing urbanization correlates with increased risk, as unplanned growth rarely takes account of physical hazards' (2000: 95). All over the world, vulnerability is what determines the degree of risk to which people are exposed. However, the roots of vulnerability as a concept stem from the study of rural livelihoods (Pelling, 2003). Vulnerability is an important aspect of the risk to which urban dwellers are subject, because some hazards affect this group only indirectly. Vulnerability has three components: exposure, sensitivity and resilience (Turner *et al.*, 2003). Efforts to reduce vulnerability must thus address at least one of these three aspects successfully.

Although rural populations are traditionally associated with greater poverty, it has been suggested that that urban populations are now more vulnerable to hazards (Moser *et al.*, 1994; Pelling, 2003). Greater wealth disparity is represented in urban societies, where the landless and homeless beg at the feet of CEOs. But positive discrepancies also abound in cities, which are infused with intellectual, cultural and social diversity. Further, cities are 'engines of economic growth and centres of innovation for the global economy and the hinterlands of their respective nations' (De Sherbinin *et al.*, 2007: 39). Livelihood diversity is also apparent. While urban populations do not typically depend directly on natural resources for their survival, their incomes are often reliant on rural populations either for the provision of primary commodities, or for the purchase of processed goods and services. In many ways, therefore, urban populations are more sensitive to changes in climate.

In some cases, cities clearly have more power to address their needs than bordering and rural areas do. In the city of Cebu in the Philippines, water resources are being allocated primarily to the city at the expense of both the environment and the rural areas outside the city (Hafner *et al.*, 2003). But the city, where the more powerful and significant constituency reside, will have far more political weight than rural dwellers. The urban-rural trade-off is a relatively new area of exploration within the context of global environmental change studies (IHDP, 2005).

The line between urban and rural becomes blurred in many cases. When urban settlements encroach on surrounding rural areas, it is difficult to identify the physical location where urban becomes rural and vice-versa. Also the characterisation of urban-rural as a type of dichotomy has been dispelled by the recognition of the significant economic and social interdependency between the two (Moran, 2006). Furthermore, people of a range of income categories from business owners to construction workers who live in rural or peri-urban areas may commute to cities daily for work, spending most of their time and money in the urban setting. But regardless of where people are located, there are a unique set of risk issues posed by an urban environment that are not found in a rural setting.

Rural development focuses on access to and quality of land and water resources, provision of basic services such as medical care and education and infrastructure and communications to facilitate market access. Responses to climate change in rural areas pivot on these building blocks, often directly targeting water resources management and agricultural productivity and practices. Disaster risk-related activities emphasise grain storage, storm protection and networks. Activities address infrastructure, as well as behavioural issues. Perceptions of risk based on cultural belief systems are important, but rarely recognised (Schipper, forthcoming).

Urban development, on the other hand, must focus on creating order from chaos. Cities are a hodgepodge of interests, agencies and institutions. They need to interact so that one person's improved wellbeing does not come at the cost of another person's decent into poverty. Typically, such an arrangement is rare. Population dynamics are thus more important in an urban setting, which is typically not as homogenous as a rural setting. Urban settings are also consequently more individual focused than community focused. Partly due to the issues of scale – cities are defined by their population size and rural settlements are often sparsely and less densely populated. Population growth in cities is also driven by rural emigrants, arriving in cities to seek employment and economic opportunities, although as noted above, there may also be a share of out-migration from cities, among city residents who are pushed off marginal land. In some countries, like Ethiopia, the national government attempts to create incentives for rural settlers to remain in rural areas, under the policy of 'agriculture-led development' that encourages conventionally rural activities. Despite this, Morrissey notes that research in the north-eastern Ethiopian highlands shows that environmental change does trigger migration (2008).

Satterthwaite (2008) argues that that the urban poor tend to live in the most hazardous urban environments, such as floodplains and on hillslopes. But lessons learned from the landslides in San Salvador following the two earthquakes in early 2001 indicate that not only the poorest are at risk in cities. The residents living in Santa Tecla (Nueva San Salvador) and Comasagua where the landslides took place were mostly middle class. However, while even

the wealthier may also be exposed to hazards, in generic terms the poorest tend to be the most sensitive to it. The poorest, who are often engaged in the informal economy, are often ignored by legislature and planning. Not only does this anchor them in a vicious cycle of poverty, but it also means that they are marginalised from decision-making processes. Consequently, they often get displaced. An anticipatory measure, therefore, is to choose the most hazardous locations to live, in order to avoid eviction, in the hope that there is no other possible use for the land. Among the poor, therefore, the most at risk include those who are least able to avoid the direct or indirect impacts of hazards, and the least able to cope will the resulting impacts (Satterthwaite *et al*., 2007).

Despite this, it is not reasonable to lump all 'poor' people into the same category. The risk posed by climate change, and the capacity to cope with it and ultimately adapt to it, will be location specific. It will depend on the people in question and the social dynamics in which they live, including their livelihood strategies. Clearly, state of environment will also play a major role, as will the types of hazards to which the people are exposed. It is important not to forget that also the political environment, as well as power relations have significant influence. And not least is the importance of existing institutions and plans, and their strengths, including the extent to which disaster risk reduction plans exist.

Responses to Climate Change in Urbanizing Societies: Key Entry Points

Urban adaptation to climate change can be defined as the sum of all physical and organisational adjustments to urban life that will be required to cope with the profound and durable changes in weather and climatic patterns.

Bigio (2003: 94)

Cities can play a critical role in solutions to problems posed by climate change.

Sanchez-Rodriguez et al. (2008)

Choosing the right way to approach climate change in urban areas is fundamental. Adaptation must begin by addressing the factors that underlie vulnerability to climate change and rapid urbanization, but must consequently also have a long-term perspective in order to avoid being maladaptive. Measures addressed at the impacts of climate change only will largely fail to address the long-term consequences of climate change, but more importantly will unlikely address the challenges posed by urbanization. Adaptation in cities will by necessity therefore need to be part and parcel of solutions to urbanization's problems, including poverty. Sanchez-Rodriguez *et al.* (2008: 5) explain that 'well-intended fragmented actions create, in the best case, only partial solution to problems and can cause new problems or aggravate existing ones'. Sanderson comments that increased vulnerability is an outcome of much urban legislation, for example 'withholding tenure inhibits consolidation of buildings, resulting in poorly-built shelters that easily collapse, catch fire or harbour disease' (2000: 101). In other words, this process is not just about mainstreaming adaptation into urban planning, but about getting urban development right.

There will be a need to look at existing processes for planning, zoning and decision making, and understand the drivers of decisions. There will be a need to see how to integrate climate change concerns into existing plans so that 'win-win' options can be chosen. The example of elevated walkways in Bangkok shows that people would benefit from this for many reasons, including protection from potential flood water and associated diseases. All of these will hinge on good governance, and more specifically on adequate policies and institutions. Pelling (2003) also suggests that a supportive institutional framework can transform social capital present in many vulnerable communities into social organisation to build adaptive potential.

Adaptation activities are difficult to design because they depend on the impacts of climate change and their secondary effects. So-called 'win-win' or 'no-regrets' adaptation measures are those activities that address adaptation, while simultaneously meeting other needs, and are not in conflict with development objectives, nor lead to circumstances that will increase vulnerability to climate change. But sometimes the cost of adaptation is high, and decisions about how to design interventions will need to be balanced against certainty about impacts. For this reason, existing adaptation initiatives are primarily focused on strengthening capacity to assess impacts and vulnerabilities to them, and carrying out climate-proof development projects and activities related to disaster risk reduction. All of these activities can be considered 'win-win' but may carry additional costs.

It is important to understand adaptation as a process (Schipper, 2007), because it helps justify why it is necessary to think carefully about how adaptation is implemented. In particular, thinking about adaptation as a process explains why measures to adapt now may need to be adjusted in the future in response to changes, including environmental, social, political, financial, etc. Framing adaptation in this way also explains why adaptation is not a tangible outcome that can be measured exhaustively at any given time, but rather seen as an evolving objective.

Adaptation requires planning, but it careful thinking is required to identify exactly which institutions, policies and processes need to be adjusted and which need to be entirely overhauled. What are the necessary changes to reduce vulnerability in the long term and avoid the emergence of new drivers of vulnerability? What kind of adaptation strategies are needed in the short and longer term to prevent climate change from exasperating the already significant policy challenges linked to rapid urbanization? Clearly the pattern of urbanization may be one of the things that needs to be planned as part of an urban adaptation strategy. So what are the entry points for improved city-planning to reduce pollution, e.g. through better waste-management, improved water supply and sanitation, and mass transport options? How do efforts to reduce environmental damage and improved infrastructure to improve drainage and water catchments to better cope with higher and/or lower levels of precipitation figure into urban development plans and adaptation strategies?

In their studies of climate change in Latin American cities, Sanchez-Rodriguez and colleagues (2008: 8) identify additional questions with regard to responding to climate change in cities:

- Which urban areas have committed to respond to climate change?
- What are those responses?
- Which actors are involved in those responses?
- What are the driving factors for those responses, and how many of them are rhetoric and how many tangible?
- What are their institutional settings?
- Are these responses sustainable in the future?
- Are there conflicts and contradictions between mitigation and adaptation responses?
- Are there perceived consequences in terms of social equity?
- Can the experiences of current responses be used to foster other urban areas to respond?

The fundamentals of urbanization must figure prominently in thinking about adaptation. One of the questions related to urbanization is how to reconcile short and long-term priorities so that vulnerability is not increased in the medium and/or long term as a consequence of a focus on short-term priorities. Poor people – i.e. those who end up in slums – gravitate toward cities in order to address immediate needs. These are people with few, if any, assets, who are typically seeking to feed themselves or their family, not dreaming of a long-term plan to build a business or gain an education.

Bigio (2003) suggest that some of the adaptation options include:

- generation of reliable and comprehensive assessments of risk vulnerabilities for the exposed cities, and the dissemination of such information;
- establishment of early warning systems and evacuation plans, including emergency preparedness and neighborhood response systems;
- the improved efficiency of water supply management, by minimizing leakages and instituting marked-based pricing mechanisms;
- improving health education and institutional capacity in urban environmental management;
- regularizing property rights for informal settlements and other measures to allow low-income groups to buy, rent, or build good quality housing on safe sites;
- 'hardening up' of the infrastructure systems, including storm-drainage systems, water supply and treatment plants with protective physical improvements;
- protection or relocation of solid waste management facilities, energy generation and distribution systems;
- consolidation of hydro-geologically fragile areas.

These are the types of measures that need to be supported by institutions and policies.

Currently, with growing interest in cities and adaptation, more studies are becoming available. Despite this, however, few examples of implemented adaptation plans exist. The

most prominent ones stem from North America, Europe, Australia and South Africa. In the context of development, the examples of Durban (Roberts, 2008) and Cape Town (Mukheibir and Ziervogel, 2007) are useful. This does not mean that it is less complicated or costly to adapt to climate change in cities in developed countries. In reality, it may be far costlier to adapt cities where additional and new investments in urban development are not necessary. In developing countries, on the other hand, many cities can not only benefit substantially from this, but also desperately need it.

There are also implications with respect to time scales. Adapting to the impacts of climate change may imply putting off action until impacts are experienced. This does not fit well with the timeframe for urban planning, given the current growth rate in developing country cities. The main adverse consequence of not getting the timing right with adaptation is the possibility of maladaptation. Pursuing adaptation without taking into account differences in present and future priorities and conditions is equally as dangerous as designing adaptation strategies without taking conflicting development trends into account. It is for this reason that long-term urban planning is required for appropriate and effective adaptation to climate change to be implemented.

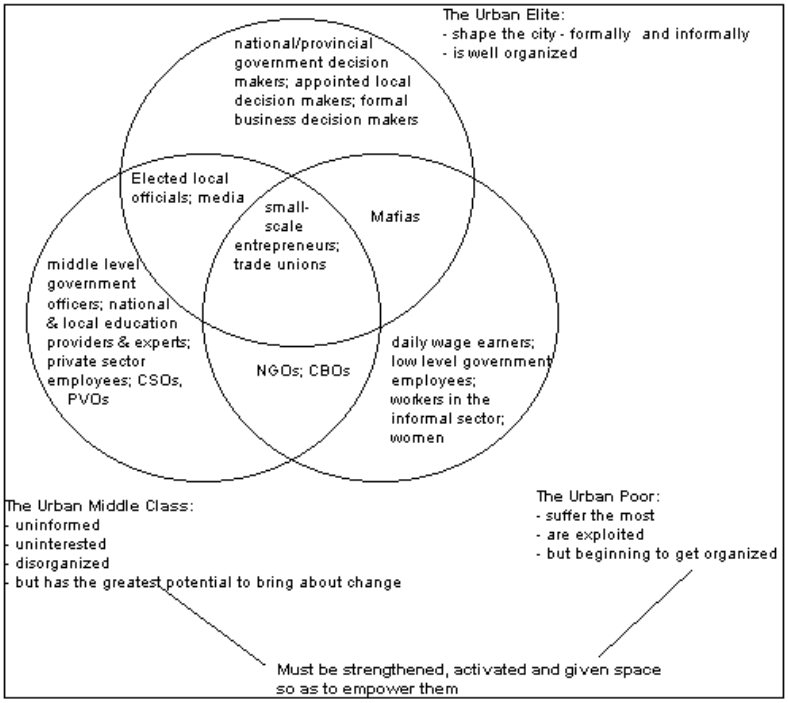
Based on these realities, this section discusses key issues around institutions, planning and infrastructure, and policies with respect to adaptation in cities.

Institutions

Numerous studies have acknowledged the role that institutions play in adaptation to climate change, especially in relation to development. Sietz *et al.* stress that 'effectively performing institutions are at the core of reducing vulnerability' (2008: 3). Sanchez-Rodriguez *et al.* urge 'increased attention to institutional change within metropolitan areas' and note that 'institutional change is also very strongly interrelated with changes in beliefs' (2008: 24). Transforming institutions will entail a range of interventions, depending on country- and city-specific circumstances. But such efforts are only worthwhile in conjunction with critical reflection on how to most efficiently and effectively use institutions to address adaptation and urbanization.

The process must **begin by identifying existing institutional arrangements**. Without going into a lengthy discussion on the definition of institutions, this paper uses the term to include both formal and informal organisations, processes and relationships found in a city. Institutional arrangements include the various branches of local government, but also all of the other actors. These include – but are not limited to – regional and national governments, citizens (legal and 'illegal'), civil society groups, the private sector, and external actors such as donor agencies (see Figure 2). Understanding the role that each of these stakeholders plays is crucial. It is also necessary to be aware of the informal sector, and the mobility patterns of those involved in the informal sector. Urban residents are conventionally defined as those who have their domicile in cities, but where does that leave construction workers in Bangkok who are bussed in and out every day to work in the city but sleep in rural areas?

Figure 2. Actors in urban decision making



Source: UNESCAP (2009)

Institutional dynamics, including official and unofficial relationships, types of relationships, information dissemination pathways, are all part of this picture. The next question is to ask **how are these institutions relate to climate change**? Clearly, the flow of climate information is an aspect of this, as well as development plans and objectives. Is it possible that institutional arrangements are dependent on a certain set of actors or processes that are vulnerable to climate change, whereby the possible demise of this institution will lead to a collapse of the entire institutional architecture. It is also necessary to **understand how the institutions relate to adaptation to climate change**. Institutions that have nothing to do with climate information or indeed climate change may be instrumental in driving adaptation.

Box 6. Putting climate change on the agenda: The Durban case

Following the change of government strategy in South Africa after the fall of apartheid in 1994, the Government had a massive task on its hands to include all sectors of society in development plans. Local government were seen as key actors in this regard, 'given its direct interface with local communities and its pivotal role in service provision' (Roberts, 2008: 523).

Because of tensions between the development agenda and environment agenda, as well as between long-term and short-term needs and priorities, climate change was squeezed in the middle. Roberts recounts how very little internal institutional momentum and knowledge was built around the issue of climate change, in part because municipalities did not have an understanding of climate change science nor its local relevance. In her 2008 paper, she describes that 'without developing a meaningful understand of the science, climate change and its significance are unlikely to be effectively understood at the local government level'

(2008: 525).

The example from Durban illustrates that certain conditions are necessary to ensure institutional and individual ownership of climate change as an important issue. Roberts suggests the following 'institutional markers':

the emergence of an identifiable political/administrative champion(s) for climate change issues;

the appearance of climate change as a significant issue in mainstream municipal plans;

the allocation of dedicated resources (human and financial) to climate change issues; and

the incorporation of climate change considerations into political and administrative decision making.

Based on how these were met in Durban, Roberts concludes that 'reasonable progress' has been made in mainstreaming climate change concerns at the local government level. She notes that capacity building of local government personnel was 'key to unlocking this process', and suggests that this can also 'unlock endogenous resources and interest in climate change – ultimately making the likelihood of sustainable climate protection interventions greater' (2008: 536).

Source: Roberts (2008)

But two fundamental questions remain regarding institutions and adaptation: (1) what role can institutions play in supporting adaptation?; and (2) how can institutions themselves adapt? The former question suggests that the mere existence of institutions in not sufficient for adaptation (Schipper, 2004). As a component of 'adaptive capacity', institutions are in place to provide structures for decision making, and enforcement of regulations (such as zoning). They also provide social capital, in the form of networks and human resources. But what will allow these institutions to operate as they should to reduce vulnerability to climate change? Sietz *et al.* (2008) ask what constitutes the capacity of institutions to perform climate specific functions, solve problems of climate impacts and manage adaptation to adverse climate impacts?

In response to how institutions can adapt, Sietz *et al.* (2008: 4) suggest that the following criteria are necessary for three different levels of institutional capacity, based on a study in Mozambique:

Individual

- Sufficient staff and experts for climate vulnerability assessment, development of climate adaptation strategies, design and implementation of climate adaptation policies;

- Reasonable level of climate-specific skills;
- Individual attitudes, knowledge, behaviour and awareness of climate impacts; and
- Ability to develop of individual skills and learning through appearing opportunities.

Organisational

- Specific mandate on climate issues;
- Focal points on climate issues within an organisation;
- Provision of climate data and information systems; and
- Organisational structures, processes, resources and management abilities.

Enabling environment

- Societal support for climate adaptation;
- Level of commitment and cooperation on climate adaptation;
- Leadership of an organisation on climate issues;
- Allocation of responsibilities within the mainstreaming processes of climate adaptation;
- Underlying public sector strategies for climate policy integration;
- Creation of opportunities to enable efficient use and development of skills and resources; and
- Political accountability, independence and transparency in decision-making processes.

Institutions need to be inherently flexible in order to be able to cope with climate change impacts. But first and foremost they need to be able to cope with the various processes of urbanization. Because of the rate of change in some cities, rigid institutions will be not be appropriate for addressing new circumstances and challenges. Although climate change will in many ways take the form of existing stresses and amplify these, climate change can be seen as new and additional challenge that cities have to overcome. Therefore, to handle the additional pressures presented by climate change, institutions important for cities need to be flexible as a baseline. Whether these institutions can handle a rapid influx of new settlers in cities caused by food insecurity in rural areas, for example, or health problems resulting from hotter temperatures putting pressure on medical systems, is not guaranteed.

One of the largest difficulties to overcome in terms of institutional strengthening is to reverse the inadequate coordination between governing units. Government institutions are notorious for not communicating with each other. The example of different institutions dealing with disasters can be found all across the world. Typically, the split is between a government branch dealing with disaster response and relief, and another unit, often placed in a different ministry, dealing with disaster risk reduction (i.e. prevention). The units dealing with disaster risk reduction often do not mention disasters, and may be concerned with planning, and even climate change adaptation. To add further complexity, Sanderson (2000) notes that disasters are rarely included in urban development strategies, and conversely disaster management

rarely includes urban areas. For examples in Ghana and Ethiopia, disaster management strategies do not even take urban areas into account, and in India disaster response activities fall under the Ministry of Agriculture, also predominantly rural in focus (Sanderson, 2000). The example from Durban (Roberts, 2008; see Box 6) suggests that if climate change is not seen as an issue that individuals feel passionately about, it will be left out, however it is possible to create that ownerships based on four 'institutional markers' identified through the Durban experience.

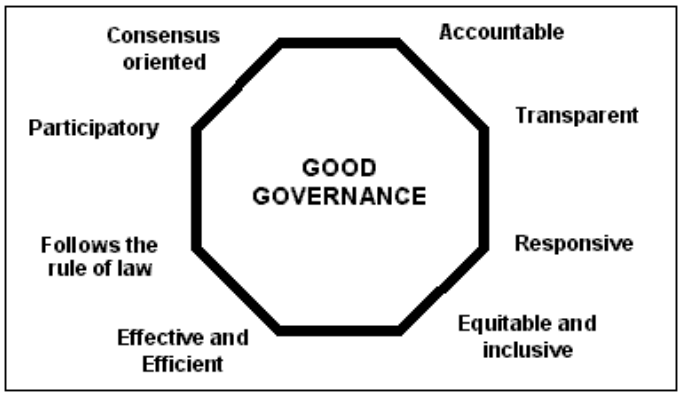
Another worthwhile question in relation to adaptation is 'adaptation by whom?' (Pittock and Jones, 2000). Is it individuals or institutions that have to adapt, or both? How do their adaptation strategies interact and whose priorities count? Both Adger (2003) and Pelling (2003) make convincing cases for the role of social capital in adaptation. Adger (2003) argues that social capital is a corner stone of effective adaptation to climate change, precisely because it provides the impetus for collective action, thus generating ownership of any adaptive strategies. This is also linked with the issue of power, which is connected implicitly with knowledge. In cities, do all residents have good information about risks and choices or are most urban residents in the dark about what is happening and what their options are?

Planning and Policies

Some cities are poorly planned, and others are less poorly planned, and few cities are well planned. Still others are 'unplanned', such as Dhaka in Bangladesh (UN-HABITAT, 2008). The city has existed for several centuries, but has expanded at a rate such that the limited services have been totally unable to keep up with population growth and demand (Alam and Rabbani, 2007). The reasons behind planning and the lack thereof in cities around the world are varied depend on many factors, not least the rate of urbanization, history of the area and available resources. The principles of good planning usually intersect with climate change adaptation. Planning and effective implementation of plans and related policies require good governance, in particular because they must ensure that they do not increase vulnerability to climate change. At best plans and policies will facilitate urbanization and a process of adaptation, but at worst they will create perverse incentives that will encourage development in high-risk areas (Satterthwaite, 2008) or activities that increase vulnerability to climate change.

Good governance means that the process of decision-making and by which decisions are implemented (or not implemented) takes equity, sustainability and human well-being into account. While bad governance is being increasingly regarded as one of the root causes of all evil within our societies (UNESCAP, 2009), it is also recognised that 'good governance' is an admirable goal, but also represents an ideal that most governments do not currently achieve. Good governance is based on several components (see Figure 3).

Figure 3. The components of good governance



Source: UNESCAP (2009)

The future in a changing climate is uncertain, both in terms of the impacts and in terms of where the limitations of human adaptive capacity lie. Flexible and adaptive policies are therefore necessary. A framework for adaptive policies based on both anticipated and unanticipated conditions has been developed by the International Institute for Sustainable Development (Canada) and The Energy and Resources Institute (India) (see Figure 4). The framework suggests that certain 'no regrets' and autonomous adaptations are possible in response to anticipated changes. The authors acknowledge, however, that the most difficult aspect of policymaking is planning for the 'climate surprises' that may lie in store. The approach must therefore be based in an adaptive management approach, which includes learning processes that continuously take stock of changes and adjusts policies in response. It is an approach that is used in natural resource management, but can also be applied to policy and decision making.

Figure 4. Framework for Adaptive Policies

Framework for Adaptive Policies

Objectives	Adapting to anticipated conditions			Adapting to unanticipated conditions			
Analytical basis	Analysis of cause/effect and outcomes			Holistic appreciation of system complexity, capacity, performance and dynamics			
Adaptive policy principles	• Fine-tune the process.[4] • Incorporate monitoring and remedial mechanisms.[8] • Understand carefully the attribution of credit.[9]	• Respect history[4] • Understand local conditions, strengths and assets.[4] • Place effort on determining significant connections rather than measuring everything.[8] • Look for linkages in unusual places.[9]	• Gather multiple perspectives from range of stakeholders.[8] • Use deliberative practice to build trust and consensus.[10] • Use epistemic communities to inform policy design and implementation.[11]	• Conduct selection by evaluating performance of potential solutions, and selecting the best candidates for further support.[4] • Policies should test clearly formulated hypotheses.[5] • Evoke disturbance.[6]	• Create opportunity for self-organization and build networks of reciprocal interaction.[4,6] • Promote effective neighbourhoods of adaptive cooperation.[9] • Facilitate copying of successes.[9] • Ensure that social capital remains intact.[12]	• Match scales of governance and ecosystems.[6] • Clearly identify the appropriate spatial and temporal scale to enable integrated management.[13]	• Promote variation, diversity[4,6] and redundancy.[6]
Adaptive policy mechanisms	**Automatic adjustment**	**Integrated assessment**	**Multi-perspective deliberation**	**Formal review and continuous learning**	**Encouraging self-organization and networks**	**Subsidiarity**	**Promoting variation**
	Some of the inherent variability in socio-economic and ecological conditions can be anticipated, and monitoring can help trigger important policy adjustments to keep the policy functioning well.	Through an integrated assessment of causal factors, key impacts and scenario outlooks, policies can be crafted to perform under a range of anticipated conditions, and possibly function even under worst cases.	Deliberative processes strengthen policy design by building recognition of common values, shared commitment and emerging issues, and by providing a comprehensive understanding of causal relationships.	Policy review undertaken on a regular basis even when the policy is functioning well, will help policies deal with "emerging" issues, and can trigger policy adjustments to conditions that could not have been anticipated.	Encourage interaction and initiative to foster emergence of innovative responses to unanticipated events. Provide space for flexible responses and reduce barriers to collaboration and learning.	Subsidiarity recognizes that action will occur at different levels of jurisdiction, depending on the nature of the issue. It assigns priority to the lowest jurisdictional level of action consistent with effectiveness.	Small-scale interventions for the same problem offer greater hope of finding effective solutions.[4] Diversity facilitates the ability to persist in the face of change, and spreading risk is part of managing complex systems.[6]

Source: IISD and TERI (2007)

Box 7. Relocation: The ultimate form of adaptation?

In December 2008, the Executive Secretary of the UNFCCC said in a press conference that relocation by populations of small island developing States was 'depressing' and showed that they are 'giving up'[5]. But is relocation actually an option only for those who have lost faith, or is it actually a realistic solution that should be considered already now?

At the 60th session of the UN General Assembly in 2005, Kiribati's President, Anote Tong, mentioned the need for nations to seriously consider the option of relocation – the 'ultimate form of adaptation to climate change' (Loughry and McAdam, 2008). In late 2008, the President of the Maldives, Mohamed 'Anni' Nasheed, proposed to buy land somewhere to resettle the population. These small islands are aware of their vulnerability to sea-level rise, and are taking their future seriously. Other places may not perceive the threat as directly, but may be equally as vulnerable.

Would it be possible, for instance, to simply move a coastal city inland? What would the implications be for the surrounding communities, the peri-urban landscape and the ecosystems? If island residents are considering abandoning their lands, the concept of relocating an entire city is not totally outlandish. There are many examples of cities that have been destroyed in earthquakes, hurricanes or other storms, and have simply been rebuilt on top of the previous ruins. Research on recovery processes following disasters shows that even when new housing settlements are built in new locations, people tend to return to their previous home – even if it is 'high risk' (Christoplos *et al.*, forthcoming). There are a number

[5] http://www.nzherald.co.nz/world/news/article.cfm?c_id=2&objectid=10547375

of reasons behind this, but they are usually related to livelihood activities, mobility and social connections. But what if there was a collective and agreed retreat?

How does relocation relate to migration, and how might these processes conflict? Migration requires making decisions that involve risk, because people give up their livelihoods to look for better opportunities. But if the entire socio-political structure of their old homes followed them to their new homes – these risks would no longer exist. The UN High Commissioner for Refugees (2008) has noted that humanitarian consequences of climate change have been given little thought, and cautions against the possibility of relocation, especially as a result of:

hydro-meteorological disasters (flooding, hurricanes/typhoons/cyclones, mudslides, etc.);

zones designated by governments as being too high-risk and dangerous for human habitation;

environmental degradation and slow onset disaster (e.g. reduction of water availability, desertification, recurrent flooding, salinization of costal zones, etc.);

the case of 'sinking' small island states; and,

armed conflict triggered by a decrease in essential resources (e.g. water, food) owing to climate change.

There are Guiding Principles on Internal Displacement that could help facilitate movement, as well as other frameworks to support the equitable treatment of displaced persons. However, as UNHCR notes, climate change may put strain on these frameworks (2008). It may be necessary therefore to reconsider more formally how displaced groups, including cities, would be treated, especially if they are relocating as a precautionary, rather than reactionary, strategy.

Financial Flows for Adaptation

Bigio (2003) suggests the following that management and institutional aspects of climate change adaptation can be just as challenging, if not more, than the financial ones. Even so, the complexity of costing adaptation for cities is clearly something that has not yet been adequately tackled. One of the biggest questions that has stunned policy makers, planners, academics and practitioners alike is how to fund adaptation to climate change. Given that cities in developing countries already require considerable additional investments in infrastructure, communications, and so on, the additional burden that adaptation will put on the public sector will not be popular (Bigio, 2003). Clearly public utility companies will need to bear a considerable portion of this burden, but the private sector will also be affected by new regulations and development laws. Although there is a common perception among civil society that with public spending directed at climate change, other aspects of urban development might be neglected, the fact is that most of the vital aspects of urban development will be linked to climate change. What is important to emphasise is that all economic growth will not reduce vulnerability to climate change. Indeed, some may increase both exposure and sensitivity to climatic hazards.

In 2006, the UK Government commissioned Stern Report gravely cautioned that if adaptation to climate change is not planned already now, the costs in the future when the impacts of climate change are discernable will be significantly higher. Since then, numerous additional studies assessing costs have been carried out. Some of the estimates are summarised in Table 2 below. Klein and Persson (2008) note that assessing the costs and benefits of adaptation is considerably more complicated than it is for mitigation of greenhouse gas emissions. Agrawala and Fankhauser (2008) say that there is very little quantified information on the costs of adaptation in developing countries, and most studies are constrained to a few sectors within countries (mostly coastal zones, but also water, agriculture and health). Klein and Persson (2008) also point out that most of the studies consider temperature changes and sea-level rise and give little thought to abrupt changes in mean conditions and to changes in the frequency and magnitude of extreme events.

Table 2. Resources estimated for adaptation

Source	Resources estimated for adaptation	Comments
UNFCCC (2007)	$60–182 billion in 2030	Infrastructure would cost between $8-130 billion in 2030 (high uncertainty), 1/3 for developing countries.
World Bank (2006)	$9–41 billion per year	Incremental costs of adapting to projected impacts of climate change in developing countries
Oxfam International (2007)	>$50 billion per year	.
UNDP (2007)	$86-109 billion per year	Adaptation in developing countries

Notably, the costs of adapting to climate change in cities cannot easily be extracted from these calculations. As noted, the studies take a sectoral approach, rather than a geographical one. To our knowledge, there are no large-scale studies on costs of adaptation to climate change specific to developing country cities. The estimates for adaptation worldwide provide a certain degree of guidance as to the magnitude of the costs. It could be useful to have a sense of the spectrum of costs of urban adaptation – including everything from protective infrastructure to physical relocation of urban centres. Nevertheless, the degree of uncertainty for such estimates would be considerable, and it is valid to question how worthwhile such an undertaking might be, judging from the high degree of uncertainty associated with the infrastructure costs in the UNFCCC study.

The source of this funding is also unclear. While the public sector in developing countries can hardly meet the financing needs of existing priorities, it has been a matter of discussion for decades that ODA should not be the main source of adaptation funding. Klein and

Persson (2008) describe possible sources, particularly in the context of the UNFCCC. While the Kyoto Protocol's Adaptation Fund is now almost on its feet, it has no specific provision for cities. Furthermore, with the given global financial crisis, the amount of funds available in the Adaptation Fund from the share of proceeds from the Clean Development Mechanism is dwindling before it even makes it into the Fund.

Recommendations to Enable Urban Adaptation

Satterthwaite suggests that there are four critical aspects of adaptation in cities (2008): long-term protection, pre-disaster damage limitation, immediate post-disaster response, and rebuilding. While a focus on disaster risk reduction is a part of adaptation, it is not the only aspect. Long-term thinking and anticipatory action to avoid increasing vulnerability in the course of the development process are also necessary. Furthermore, there must be strong governance focused on sustainable development, supported by appropriate institutional arrangements, planning and policies. These must also not only fit into existing strategies to approach urbanization, but be part of them. This section suggests some concrete recommendations for including adaptation in urbanization processes.

1. Monitor urbanization and climate change processes in a city. In order to take action to reduce the problems posed by urbanization and climate change, cities must be aware of the dynamics of these processes. Climate change projections, migration rates, the characteristics of the informal sector and other factors must be known, so that appropriate planning can take place.

2. Be aware of the actors and stakeholders. Cities are dynamic, and thus the key actors in adaptation may not be residents in cities. Similarly, the actors and the stakeholder may not be the same. Vulnerability to climate change is unevenly and inequitably distributed, so the way in which different stakeholders experience climate change will be relevant for any adaptation planning. Different stakeholders will also have divergent roles to play in adaptation. One person or group's adaptation must not come at the cost of another's decent into poverty.

3. Make policies and institutions flexible and adaptive. Decision making structures for city development must be able to cope with change. They should be regularly reassessed and adjusted in response to environmental and other changes taking place. This will not only be necessary for adapting to climate change, but also for addressing the turbulent features of urbanization.

4. Make infrastructure and physical features in cities flexible and adaptive. To the extent possible, physical development in cities needs to be able to accommodate changes. This is not only to avoid the risk of lost investments, but also because infrastructure contributes to creating risk in cities. City layout can obstruct or facilitate evacuation routes, encourage or discourage settlement in 'bottleneck' and high-risk areas, and set the premise for future development. This is related to ensuring that zoning regulations are followed.

5. Ensure that zoning laws are implemented, obeyed and enforced. Marginal people settle in high-risk zones because they are more likely to be empty and the settlers less likely to be evicted. But high-risk zones should be empty because they are not suitable for habitation. City authorities must not turn a blind eye to people who are settling in areas that increase their risk of flooding or other hazards. While this may be in conflict with the need to integrate the landless and homeless into the formal sector, it must not be accepted. Slum dwellers living in or near city dumps, for example, are not only being exposed to health risks, but also contributing to spreading disease through dense settlements. Their presence also implies potential negotiation in order to improve conditions of the dump, which may also need to be relocated as a city expands.

6. Link adaptation and mitigation and integrate them into development plans. In urban areas, many of the planning issues that are related to increasing well-being of citizens, controlling environmental degradation and encouraging private-sector investment will have implications for either greenhouse gas emissions or hazard risk. Contentious planning should ensure that green spaces are linked with public transport that will not only minimise the need to drive, but also ensure that people have good access within a city, so that they do not have to settle in unsustainable patterns.

7. Expand disaster risk reduction plans to reduce vulnerability to hazards. Assessments of hazardous areas can help identify areas that should not be developed. Once zoning is passed to prevent development in those areas, enforcement is essential. Also necessary is the allocation of alternative areas for urban development/affordable housing to prevent informal settlements in the areas that should not be developed, such as unstable slopes, vulnerable waterfronts, etc.

Concluding Thoughts

Adaptation is not an impossible process to achieve; it is already beginning in many places. This paper has not sought solely to examine adaptation options for cities, which will be context specific. It has attempted to understand the intersecting areas between urbanization and climate change impacts, identify the key questions to ask, and examine the possible entry points for addressing the compounding effects simultaneously. The IPCC note that well-governed cities have inherently high adaptive capacity (Wilbanks *et al.*, 2007). But 'whether this high adaptive capacity will actually produce appropriate adaptation is another issue' (Satterthwaite, 2008: 10). How can we move from poorly governed to well governed to well governed and well adapted cities?

Ian Burton (2004) speaks of the 'adaptation deficit' – i.e., the gap between the adaptation that is possible without additional policy or projects and the level that is needed to avoid adverse effects of climate change. The adaptation deficit describes the amount of additional effort required to manage the impacts of climate change in order to make up for the failures in managing existing climate variability, emphasising the massive scale of the gap. It would also be possible to speak about an 'urbanization deficit', indicating the gap between existing failures to accommodate all urban citizens and the likely level of services, infrastructure and institutions needed to meet future urban needs. This paper has tried to identify how to bridge the efforts to close these two gaps, which are closely related.

Poor institutions, infrastructure and regulations in developing country cities are obstacles to sustainable development but should be seen as opportunities for adaptation. They represent entry points that offer 'win-win' solutions to major developmental needs while also securing cities in the face of climate change. Urban risk is fuelled by the same factors that determine vulnerability to climate change, and thus adaptation to climate change in an urban setting will be required to address these factors. Just as addressing urbanization cannot be done without looking at governing institutions and policies, the process of adaptation to climate change relies heavily on adequate governance systems. Several ongoing initiatives examine options for adapting in cities, and with the recognition that the large majority of humanity populate cities, future studies are planned. Resulting efforts must tackle the causes underlying current failures in institutions and policies in cities, especially those related to managing and reducing urban environmental risk. And they must acknowledge the limits to adaptation to climate change.

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Annex I: Key Definitions

Adaptive Capacity

Adaptive capacity refers to the degree to which individuals or groups can adapt to risk at any given time. Usually, adaptation projects aim to enhance adaptive capacity, because adaptation is a long-term process beyond the temporal scope of any project. The main problem with adaptive capacity is that it essentially refers to all aspects of development. In the TAR (IPCC, 2001), the IPCC outlined a number of factors that determine adaptive capacity; this list could just as easily have referred to factors that determine sustainable development. Adaptive capacity is one of the main concepts linking adaptation and development.

Climate change and climate variability

Climate change involves a change in climate parameters, such as temperature and precipitation, in terms of timing, magnitude, distribution or all three. This change is measured in terms of how it differs from average values, as well as discrepancy with 'normal' climate variability, which refers to the 'variations in…climate…beyond that of individual weather events' (IPCC, 2007). Climate change generally refers to human-induced changes. Importantly, the UN Framework Convention on Climate Change (UNFCCC) addresses only climate change. The IPCC defines climate change as 'a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use' (IPCC, 2007).

Coping

Coping is sometimes used as a synonym for adaptation, however coping measures are generally short-term actions to ward off immediate risk, rather than to adjust to continuous or permanent threats or changes. In some cases, coping strategies can in fact deplete assets such that recurrent hazards pose a higher risk. It is therefore important to distinguish between coping and adapting.

Extreme events

An event that is rare within its statistical reference distribution at a particular place. Definitions of 'rare' vary, but an extreme weather event would normally be as rare as or rarer than the 10^{th} or 90^{th} percentile. By definition, the characteristics of what is called 'extreme weather' may vary from place to place. Extreme weather events may typically include floods and droughts.

Source: IPCC (2007)

Impacts

Impacts refer to the way a human or natural system reacts to climate change. Often, reference to impacts refers also to secondary and tertiary consequences. For example, climate change can result in less rainfall, which will inhibit crop growth. This is either because it means less water falling on plots, less groundwater recharge, or less water in streams from which water

is taken to irrigate crops. The secondary consequences of this is less crop product, which can lead to economic difficulties or hunger.

Maladaptation

Any changes in natural or human systems that inadvertently increase vulnerability to climatic stimuli; an adaptation that does not succeed in reducing vulnerability but increases it instead. Maladaptation can take place when the development context is not considered explicitly in designing and implementing adaptation measures.

Resilience

Resilience has its roots in ecology and has two different applications for ecological systems, which are now also widely found in the discourse of social systems. Resilience may either refer to the extent to which a system is able to absorb adverse effects of a hazard, or it may refer to the recovery time for returning after a disturbance. In this sense, highly resilient systems are either characterised by their ability to endure despite high stress, or their ability to bounce back quickly. From this perspective, resilience can be described as a buffer, or a shock absorber, allowing individuals or systems an opportunity to cope during an event and not depleting all resource or options for recovery following an event. It is therefore seen to have links with the adaptive capacity and vulnerability of a system.

Risk

Risk is used in many different contexts. In terms of environmental change, it either refers to the threat posed by a change, i.e. the probability of an adverse impact. Climate change risk is a function of the magnitude of an individual hazard and degree of vulnerability of a system in question to that hazard, according to the conceptual equation Risk = f(Hazard, Vulnerability). Generally, unless a system is vulnerable to the hazard, there is no risk implied.

Vulnerability

Vulnerability to environmental change has been defined and redefined since the early 1980s. Vulnerability describes how sensitive an individual or system is to a specific hazard, and is sometimes described as sensitivity, which may refer more commonly to ecological systems. Vulnerability is determined by numerous factors, including geographical location, gender, age, political affiliation, livelihood, access to resources and wealth (entitlements), etc. The most useful element of the concept is the notion that a hazard does not translate directly into risk, but rather is qualified by the degree of vulnerability of the individual or system in question to that hazard. The underlying factors causing vulnerability are what therefore determines risk. It is for this reason that poverty is often considered one of main drivers of risk, but in reality there are a number of other significant factors that should not be overlooked, including belief systems and influence on decision makers, that also drive vulnerability.

Disaster risk reduction

Disaster risk reduction includes the suite of interventions, approaches and policy frameworks needed to avoid or minimise the impacts of natural hazards on societies and the environment,

focusing on reducing vulnerability to hazards. Disaster risk reduction includes the concept of disaster accumulation, i.e. it reflects that each disaster event reduces the ability to cope with the next event.

Mitigation

An anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks.

Hazards

Hazard is a physical event (natural hazard) that can pose a threat to a system if the system is vulnerable to the hazard. Hazard is often used in a way that implies risk, but in reality if a flood occurs in an area that is not vulnerable to floods, there is no risk involved. Of course, risk without hazard is not possible, and therefore hazard is conceptually linked with damage and loss.

Urbanization

The conversion of land from a natural state or managed natural state (such as agriculture) to cities; a process driven by net rural-to-urban migration through which an increasing percentage of the population in any nation or region come to live in settlements that are defined as urban centres.

Source: IPCC (2008)

Annex II. Urban population statistics and projections (UN, 2006)

Most of the population increase expected during 2005-2030 will be absorbed by the urban areas of the less developed regions whose population will likely rise from 1.9 billion in 2000 to nearly 4 billion in 2030. The urban population of the more developed regions is expected to increase very slowly, passing from 0.9 billion in 2005 to 1 billion in 2030.

During 2005-2030, the world's urban population will grow at an average annual rate of 1.8 per cent, nearly double the rate expected for the total population of the world (1 per cent per year). At that rate of growth, the world's urban population will double in 38 years.

Growth will be particularly rapid in the urban areas of less developed regions, averaging 2.2 per cent per year during 2005-2030, consistent with a doubling time of 30 years. In contrast, the rural population of the less developed regions is expected to grow very slowly, at just 0.1 per cent per year during 2000-2030.

The rapid increase of the world's urban population coupled with the slowing growth of the rural population has led to a major redistribution of the population. Thus, whereas in 1950, 30 per cent of the world population lived in urban areas, by 2000 the proportion of urban dwellers had risen to 47 per cent and is expected to reach 60 per cent by 2030. The number of urban dwellers will for the first time have overtaken the number of rural dwellers in the world in 2008.

There are marked differences in the level and pace of urbanization among less developed regions. Latin America and the Caribbean is highly urbanized, with 77 per cent of its population living in cities in 2000. Asia and Africa are considerably less urbanized, both with around 39 per cent of their populations living in urban areas. Being less urbanized, Africa and Asia are expected to experience rapid rates of urbanization during 2000-2030. Consequently, by 2030, 54 per cent and 55 per cent, respectively, of their inhabitants will live in urban areas. At that time, 85 per cent of the population of Latin America and the Caribbean will be urban.

In Europe and Northern America, the percentage of the population living in urban areas is expected to rise from 73 per cent and 79 per cent, respectively, in 2000 to 80 per cent and 87 per cent in 2030. The increase in Oceania is likely to be smaller, from 73 per cent in 2000 to 75 per cent in 2030.

Despite their high levels of urbanization, the combined number of urban dwellers in 2003 in Europe, Northern America, Latin America and the Caribbean (1.2 billion) is not as high as that in Asia (1.4 billion), the least urbanized major area of the world today. Furthermore, by 2030, Asia and Africa will both have higher numbers of urban dwellers than any other major area of the world.

Asia also has and is expected to have the largest rural population of the world during 2000-2030, amounting to 2.3 billion persons today. Africa, with 521 million rural inhabitants in 2003, is expected to see its rural population rise to 650 million by 2030, remaining the second largest during the period. Except for Africa and Oceania, all major areas are expected to experience a reduction of the rural population between 2000 and 2030.

As a consequence of regional trends, the world's rural population will remain nearly stable during 2000-2030, falling only from 3.21 billion to 3.19 billion.

In terms of population size, Tokyo was the largest urban agglomeration in the world in 2005, with 35 million residents (the Tokyo estimate has been raised considerably in the latest estimates due to a new definition of metropolitan area). Tokyo is expected to remain the largest metropolis although its population will not grow substantially. It is followed today by Mexico City, New York, Sao Paulo and Mumbai (Bombay). Of these cities, Mumbai is expected to become the second largest mega-city in 2015 with a population of 22 million, followed by Mexico City, Sao Paulo and Delhi.